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Original Article

Effect of Low-dose Atracurium on Laryngeal Mask Airway Insertion Conditions: A Randomized Double-blind Clinical Trial

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Abstract

Background: The amount of sedation and muscle relaxation of the jaw may have an impact on complications caused by laryngeal mask airway (LMA). The aim of this study is to evaluate the effect of low-dose Atracurium on conditions of insertion, complications, and hemodynamic responses to LMA insertion following induction of anesthesia with propofol, in patients undergoing cataract surgery. **Patients and Methods:** In this double-blind randomized clinical trial study, 60 patients were randomly divided into two groups. Initially, the patients in the study group received 0.15 mg/kg intravenous injection of atracurium, and the patients in the control group received 2 ml of intravenous injection of normal saline, after which anesthesia in both groups were induced with midazolam, fentanyl, lidocaine, and propofol. The amount of jaw relaxation, ease of insertion, and the time needed for insertion, hemodynamic responses and complications of LMA insertion were evaluated. **Results:** Jaw relaxation and ease of LMA insertion in the study group was significantly better than that of the control group (P = 0.02). Average time needed for LMA placement in the study group (5/06 ± 0.52 second) was significantly lower than the control group (5/76 ± 0.67 second) (P = 0.001). Hemodynamic response to LMA insertion was similar in both groups. Sore throat at recovery and 24 h after surgery in the control group was significantly higher than that of the study group (3/30 vs. 10/30) (P = 0.01). **Conclusions:** Using low doses of atracurium decreases the time needed for LMA insertion and sore throat after the operation. Atracurium also increases jaw relaxation and facilitates the placement of LMA.

Keywords: *Atracurium, cataract surgery, insertion, laryngeal mask airway, propofol*

Introduction

Laryngeal mask airway (LMA) is one of the airway control tools for managing common airway problems under general anesthesia and airway emergency. So that, the LMA has been highly adapted to difficult airway management protocols, as a result it has been accepted as a suitable alternative for tracheal tube.[1] This airway is often an indication of patients who have difficulty with common intubation, or for whom intubation seems impossible. LMA insertion is more bearable in comparison to tracheal intubation in lower concentrations of anesthetic drugs. Furthermore, the complications of LMA including; hemodynamic changes, gagging, coughing, laryngospasm, throat wound, sore throat, and itchy throat are less than tracheal tube.[2]

To correctly insert LMA and prevent complications, sufficient depth of anesthesia, and mouth opening are needed.[3] Increased sedation of patients and relaxation of jaw muscle makes insertion of this device easier.[4] Although propofol is a selected induction drug of choice for LMA insertion, using only propofol does not provide a good condition for LMA insertion and can trigger unwanted reactions such as cough, hiccup, laryngospasm, and movement of the patient.[5] To improve the condition of insertion, high doses of propofol that can weaken the cardiovascular system are needed.[3] Adding lidocaine, opioids and/or ketamine decreases the consumed doses of propofol and increases the success of the LMA insertion.[6]

Although the utilization of muscle relaxants in patients under positive pressure ventilation suppresses spontaneous breathing and attenuates the complications of ventilator,[7] there is controversy over the effect of muscle relaxants in improving LMA insertion conditions. Cheam and Chui compared the effect of the addition of mivacurium, fentanyl or placebo to propofol for

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facilitation of LMA insertion. They concluded that fentanyl and mivacurium were equally effective in facilitating LMA insertion.[8] Chen *et al*. had suggested that the utilization of muscle relaxants does not facilitate LMA insertion, rather it results in long recovery time and increases hospital costs.[9] Nevertheless, Yoshino *et al*., believe that adding low doses of muscle relaxants to both thiopental and propofol significantly improves conditions of LMA insertion.[10]

Objectives

Considering the controversy following the use of muscle relaxants during LMA insertion, this study was designed to evaluate the ease of success in correct placement, trauma to the patient and the quality of ventilation with LMA in patients who were under anesthesia with or without the use of atracurium for phacoemulsification surgery.

Patients and Methods

Following the approval of this research by the ethics committee of Kurdistan University of Medical Sciences, and obtaining informed consent and registration of the study in the Iranian Registry of Clinical Trials (IRCT201305081766N6), 60 patients undergoing elective cataract surgery were enrolled in this double-blind clinical trial. The inclusion criteria included the American Society of Anesthesiologist physical Status 1 and 2 subjects, being able to complete the fasting (an empty stomach), has undergone phacoemulsification surgery, filling the informed consent form and is within the age of 18–80 years. The exclusion criteria included a history of musculoskeletal diseases, a history of hypersensitivity to the muscle relaxant drugs, pregnancy, the need for endotracheal tube during anesthesia, a history of hiatal hernia, a gastric esophageal reflux history, potential for difficult airway management based on physical examination, and drug or alcohol abuse. With respect to the table of computer's random numbers, patients were divided into two groups to receive 0.15 mg/kg/IV (volume of 2 ml) of atracurium in the study groups or normal saline of 2 ml in the control group for muscle relaxation before inserting LMA. Division between groups was carried out by pouring numbers into a sealed envelope. The anesthetist nurse who prepared the study medication opened the envelope just before the induction of anesthesia. This person was not involved in data collection.

After reaching the operating room, all patients received standard monitoring including noninvasive blood pressure, pulse oximetry and electrocardiography, and before any intervention, baseline values of systolic and diastolic blood pressure, and heart rate were recorded. Patients' pretreatment was carried out with 0.05 mg/kg of midazolam, while 5 ml/kg of Ringer's liquid was infused before the induction of anesthesia for all patients. Then, patients were oxygenated. Patients in the study group were injected with 0.15 mg/kg/IV atracurium (2 ml volume) while patients in the control group were injected with 2 ml normal saline. The induction of anesthesia for all patients was similar and included 1.5 mg/kg/IV of lidocaine, 1.5 mcg/kg/IV of fentanyl, and 2 mg/kg/IV of propofol (Propofol-Lipuro, B-Braun Melsungen AG Germany) respectively. Following the loss of eyelash reflexes, one disposable LMA (Hitec Medical CO Ltd China) with appropriate size was inserted according to weight for all patients using classic method by an experienced anesthesiologist who was unaware of the drug used for injection as well as the patients group. Following the confirmation of the suitability of the place for LMA and fixing it, patients were placed under ventilation with positive pressure. The maintenance of anesthesia was carried out with a mixture of oxygen, nitrous oxide 50/50 and isoflurane 0.8%–1.2%. Antiemetic prophylaxis was done following the start of surgery, using 4 mg/IV dexamethasone and 4 mg/IV ondansetron.

Age, sex, weight, duration of surgery, duration of anesthesia, and the following variables were recorded in the questionnaire by the person who inserted LMA.

The speed of insertion (time of inserting LMA from the lips until the first successful lung ventilation): LMA insertion was considered correct when there was no or very low leakage of air during ventilation with bag, chest had expanded appropriately, lung auscultation were normal, and the patient's airway pressure was ≤20 cm H_2O.

Relaxation of jaw (easy opening = relax, jaw is slightly stiff and mouth cannot be opened easily = slightly stiff, jaw cannot be opened with too pressure = hard).[11]

Ease of insertion (LMA was inserted in the first attempt within 15 second without moving = easy. LMA was inserted in the first attempt; however, it required over 15 second or more to move = a little difficult, and it took more than one attempt for a successful insertion of the LMA, taking more than 30 second = very difficult).

The number of insertion attempts is the number of times LMA was inserted into the mouth from outside until the accuracy of insertion was confirmed.

The movement of patients was carefully followed up for 2 min after filling the cuff of LMA and was defined as moving or not moving. The movement was defined as the movement of limbs, coughing, straining, and resistance to manual ventilation. Furthermore, at the end of the operation, inhalational drugs stopped, and the patient was manually ventilated tell ensuring sufficient spontaneous ventilation, when LMA was removed, and the sides of the LMA were investigated for the presence of bloody secretions. Twenty-four hours after the operation, the patient was asked for a sore throat and itchy throat. Furthermore, cardiovascular variables such as systolic and diastolic blood pressure as well as heart rate before anesthesia, after injection of anesthetic drugs, and 1 and 5 min after insertion and fixation of LMA were measured and recorded by an automatic monitor device (Saadat Co,

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Iran). Complications during the removal of LMA such as laryngospasm, nausea, and vomiting were recorded too.

Sample size calculation

In a pilot study on 12 patients, the mean required time for mask insertion without interaction was 7 second. To detect 2 second decrease in this time, we would require 29 patients in each group to achieve 90% power at 5% significance level. Hence, we recruited 30 patients in each group. Data collected were investigated using SPSS 15 software (SPSS Inc, Chicago, IL, USA) while statistical analysis was performed using *t*-test and Chi-square test.

Results

Sixty-three patients completed the informed consent form to participate in the study. The surgery of 2 patients was postponed. The movement of LMA of one patient during the surgery led to its exit in addition to the injection of anesthetic and extra relaxant, and intubation of the patient. Finally, 60 patients were analyzed. LMA was correctly inserted in 96.66% of the patients in both groups in the first attempt. The patients in both groups were not significantly different in terms of demographic characteristics, duration of surgery and anesthesia [Table 1]. Moreover, there was no significant difference between the patients of both groups in terms of hemodynamic responses to induction and LMA insertion [Figures 1-3]. In the study group, LMA was inserted in a shorter time (5/06 ± 0.52 second in atracurium group versus 5/76 ± 0.67 second in Saline group). In addition, ease of LMA insertion in the patients of the study group (30/30) were significantly better than that of the control group (25/30) (P = 0/001). Sore throat at recovery (3/30 versus 10/30) and 24 hour (0/30 vs. 6/30) after surgery was higher in the control group [Table 2]. There was no significant difference between the two groups in terms of blood around the LMA [Table 2]. LMA exists in deep anesthesia condition, coughing at the time of exiting was the same in two groups, however, at postanesthesia care unit, and 24 your after surgery the cough in control group (10 and 3, respectively) was significantly higher than study group (4 and 0 respectively) ($P < 0.05$).

Table 1: Demographic data and duration of surgery and anesthesia in two study groups

Variable	Atracurium (*n*=30)	Placebo (*n*=30)	*P*
Age; mean±SD (year)	53.4±4.7	51±5.5	0.76
Sex (male/female)	19/11	17/13	0.85
LMA size (3/4)	13/17	14/16	0/4
Duration of surgery, mean±SD (min)	35±15	32±15	0.44
Duration of anesthesia, mean±SD (min)	42±9	40±11	0.63

ANOVA test was used to compare the variables among three groups. SD: Standard deviation, LMA: Laryngeal mask airway

Discussion

Reducing the hemodynamic responses and suppressing the movement as well as coughing of the patient during general anesthesia in patients undergoing cataract surgery, causes less increase in intraocular pressure, and decrease

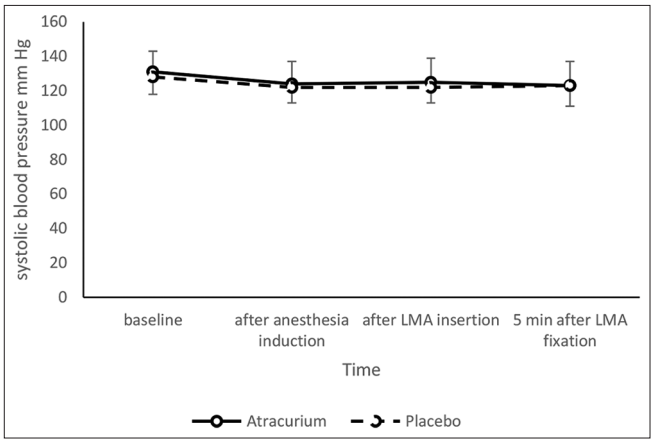

Figure 1: Systolic blood pressure during study in two groups

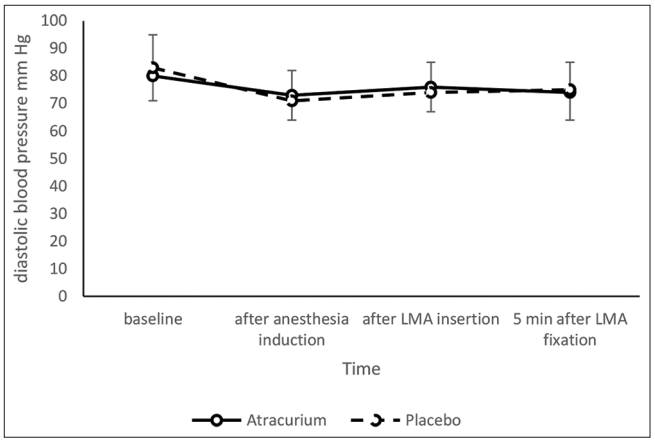

Figure 2: Diastolic blood pressure during study in two groups

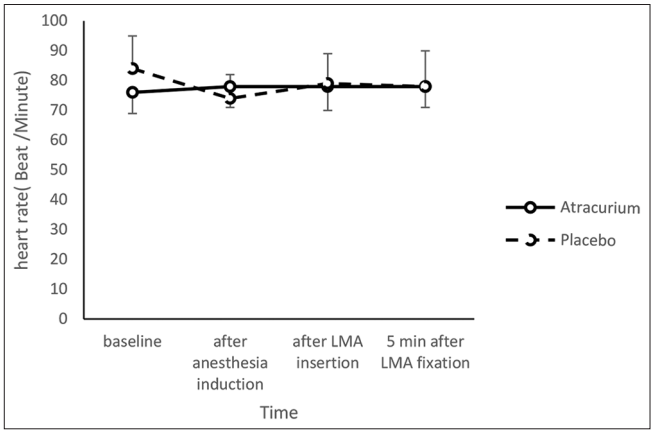

Figure 3: Heart rate changes during study in two groups

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Table 2: Laryngeal mask airway insertion conditions and its complications in two groups

Variable	Atracurium (*n*=30)	Placebo (*n*=30)	*P*
Correctly inserted LMA number (%)	30 (100)	29 (96.6)	0.6
Time required for LMA insertion; mean±SD (second)	5/06±0.52	5/76±0.67	0/001
Ease of insertion (yes/no)	30/0	25/5	<0.02*
Bloody secretion around LMA (yes/no)	1/29	2/28	0/5
Coughing in			
Postanesthesia care unit	4	10	0.06*
24 h after surgery	0	3	0.07*
Sore throat			
In postanesthesia care unit	3	10	0.05*
24 h after surgery	0	6	0.01*

*Chi-square test was used to compare variables between two groups. SD: Standard deviation, LMA: Laryngeal mask airway

perioperative complications.[12] Gentle and successful LMA placement needs comfortable opening of the mouth and stopping of airway reflexes to avoid coughing, gaging, and laryngospasm.[13] The results of our study revealed that using low doses of atracurium before propofol injection led to a better relaxation of the jaw and faster facilitation of LMA insertion. The results of other studies are different over the effect of injection of the muscle relaxant on LMA insertion condition.

Chui and Cheam compared the effect of injecting two different doses of mivacurium with normal saline on LMA insertion in patients undergoing anesthesia with propofol. In their study, both doses of mivacurium significantly facilitated LMA insertion in a similar manner when compared to normal saline.[14]

Yoshino *et al*., in their study concluded that the use of succinylcholine and thiopental facilitates LMA insertion.[10] Monem and Chohan also compared the relaxants of succinylcholine and atracurium with thiopental on the conditions of LMA insertion, and they concluded that succinylcholine provides better conditions for LMA insertion when compared to atracurium.[15] Nevertheless, both studies concluded that succinylcholine increases the incidence of postoperative myalgia.[10,15] The results of these studies are in agreement with our study. In our study, injecting low doses of atracurium also led to better conditions for LMA insertion. Nevertheless, van Vlymen *et al*. examined the need for injecting muscle relaxant on the ability to carry out tracheal intubation via the intubating LMA (ILMA).[16] They divided the patients into 3 groups. In a placebo group and two study groups, normal saline 2 ml, rocuronium doses of 0.2, and 0.4 mg/kg were utilized for muscle relaxation, respectively. Researchers did not find any relationship between the use of rocuronium and the required time for insertion and fixing of the endotracheal tube. The results of this study are not in line with our study. The possible cause of the differences between both studies is the time utilized for muscle relaxant injection (they utilized muscle relaxant after ILMA insertion for tracheal intubation), and the type of LMA used (we used a Classic LMA, while ILMA was used in above study).[16]

The results of our study demonstrated that the use of atracurium for muscle relaxation significantly decreases the time required for LMA insertion. According to the results in both groups, LMA was inserted in an average time that was less than 6 second. Nevertheless, in the studies of Chauhan *et al*., Hayashi *et al*. and Oh *et al*., this time was 15, 16, and 38 second, respectively.[17-19]

The exact cause of lower insertion time in our study in comparison to other studies is not clear. Possible reasons can be pointed to differences in pretreatment, the method of calculating the time of insertion, and experience of the person who carried out the insertion. We applied midazolam, fentanyl and lidocaine for pretreatment in our study and the time of insertion was considered when the mouth was opened for LMA insertion until the first successful lung manual ventilation for patients was carried out. Fixing time was not considered and expert anesthesiologist who had over 10 years' experience performed the insertion. Injection with midazolam, fentanyl, and lidocaine before propofol facilitate LMA insertion conditions.[20]

The results of this study indicate the relative hemodynamic stability after the induction of anesthesia and LMA insertion in both groups and no significant difference was observed between the two groups in terms of hemodynamic responses. Cardiovascular stability during anesthesia induction and LMA insertion, especially in patients who had cataract surgery, is necessary because stress responses of LMA insertion and hemodynamic changes are caused by an increase in intraocular pressure.[21] Alipour *et al*. believe that LMA insertion after the induction of anesthesia by propofol decreases intraocular pressure, blood pressure, and heart rate.[22] Most patients who undergo cataract surgery are old and therefore are at increased risk of aberrant hemodynamic responses followed by airway manipulation. LMA insertion in comparison with the endotracheal tube causes low blood pressure response and cough. Hence, the probability of increasing intraocular pressure is less.[21]

Our results demonstrated that there was no significant association between the existing blood around the LMA cuff after its exit and the utilization of muscle relaxant. Streaks of blood around the cuff were observed in only 5% of patients. While this value was 40% in the study of Ratajczyk *et al*.,[23] and 10% in studies of Abdellatif *et al*.,[24] and Nagai *et al*.,[25] which was higher than the values obtained in our study. The causes of variation in these values can be attributed to the method of LMA insertion and the presence of air in the cuff at the time of insertion. We used the classic method while the cuff was

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half filled. Half filling of the cuff before insertion enhanced conditions for LMA insertion when compared to conditions when the cuff was empty.[26]

In our study, respiratory symptoms such as a cough, itching in the throat and sore throat after surgery during recovery and 24 h after surgery in the study group were significantly less than that of control group. Chui and Cheam in their study concluded that the utilization of low doses of mivacurium alongside propofol for insertion of LMA reduces postoperative complications such as inflammation, cough, move, laryngospasm, and sore throat.[13] However, Chen *et al*., have opined that the utilization of relaxant had no effect on the incidence of sore throat which is contrary to our results.[9] The reason for this difference can be attributed to the type of surgery and the type of LMA employed. Chen *et al*. investigated laparoscopic gynecologic surgery patients where airway management was carried out through the use of ProSeal LMA.

Limitation

one of the limitations of our study was that we did not measure anesthesia depth in the time of anesthesia induction. Monitoring anesthesia depth will be done by analyses of EEG signals measured from the forehead of patient's. The major cause of this shortage was that measurement of anesthesia depth is expensive and is not routine for eye surgeries.

Conclusions

According to the results of this study, using low doses of atracurium decreases the time needed for LMA insertion and postoperative sore throat. Furthermore, atracurium increases jaw relaxation and facilitates LMA insertion conditions. Therefore, low-dose muscle relaxant is effective in facilitating insertion of LMA following anesthetic induction with propofol.

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Conflicts of interest

There are no conflicts of interest.

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